Claims

[c1] 1.A composition for electron emitters of gas discharge devices comprising a mixture of carbon nanotubes and oxygen-containing compounds of alkali-earth metals.

[c2] 2.The composition according to claim 1 wherein said oxygen-containing alkali-earth metals are alkali-earth metal oxides.

[c3] 3.The composition according to claim 1 wherein said carbon nanotubes have a diameter in a range from about 1 nm to about 200 nm.

[c4] 4.The composition according to claim 3 wherein said diameter is preferably in a range from about 1 nm to about 100 nm, more preferably from about 1nm to about 50 nm, and most preferably from about 1 nm to about 20 nm.

[c5] 5.The composition according to claim 2 wherein a proportion of said carbon nanotubes in said mixture of carbon nanotubes and alkali-earth metal oxides is in a range from about 0.1 percent by volume to about 95 percent by volume.

[c6] 6.The composition according to claim 5 wherein said proportion is preferably from about 5 percent by volume to about 90 percent by volume, more preferably from about 20 percent by volume to about 90 percent by volume, and most preferably from about 30 percent by volume to about 90 percent by volume.

[c7] 7.The composition according to claim 1 wherein said carbon nanotubes are produced by a catalytic cracking and pyrolyzing of hydrocarbons.

[c8] 8.The composition according to claim 7 wherein said hydrocarbons are selected from the group consisting of alkynes and alkenes having 2 to 5 carbon atoms inclusive and alkanes having 1 to 5 carbon atoms inclusive.

[c9] 9. The composition according to claim 7 wherein said hydrocarbons are selected from the group consisting of substituted and unsubstituted aromatic hydrocarbons having 1 to 3 rings.

[c10] 10.The composition according to claim 7 wherein a catalyst for said catalytic cracking and pyrolyzing is selected from the group consisting of nickel, cobalt, chromium, iron, mixtures thereof, and alloys thereof.

[c11] 11.The composition according to claim 10 wherein said catalyst is cobalt chromium alloy.

[c12] 12.A gas discharge device comprising an electron emitter which comprises an electrically conductive material coated with a mixture of carbon nanotubes and oxygen-containing compounds of alkali-earth metals.

[c13] 13.The gas discharge device of claim 12 wherein said oxygen-containing compounds of alkali-earth metals are alkali-earth metal oxides.

[c14] 14.The gas discharge device according to claim 12 wherein said carbon nanotubes have a diameter in a range from about 1 nm to about 200 nm.

[c15] 15.The gas discharge device according to claim 12 wherein said diameter is preferably in a range from about 1 nm to about 100 nm, more preferably from about 1nm to about 50 nm, and most preferably from about 1 nm to about 20 nm.

[c16] 16.The gas discharge device according to claim 13 wherein a proportion of said carbon nanotubes in said mixture of carbon nanotubes and alkali-earth metal oxides is in a range from about 0.1 percent by volume to about 95 percent by volume.

[c17] 17.The gas discharge device according to claim 16 wherein said proportion is preferably from about 5 percent by volume to about 90 percent by volume, more preferably from about 20 percent by volume to about 90 percent by volume, and most preferably from about 30 percent by volume to about 90 percent by volume.

[c18] 18.The gas discharge device according to claim 12 wherein said carbon nanotubes are produced by a catalytic cracking and pyrolyzing of hydrocarbons.

[c19] 19.The gas discharge device according to claim 18 wherein said hydrocarbons are selected from the group consisting of alkynes and alkenes having 2 to 5 carbon atoms inclusive, alkanes having 1 to 5 carbon atoms inclusive, and mixtures thereof.

[c20] 20.The gas discharge device according to claim 18 wherein said hydrocarbons are selected from the group consisting of substituted and unsubstituted aromatic hydrocarbons having 1 to 3 rings inclusive.

[c21] 21.The gas discharge device according to claim 18 wherein a catalyst for said catalytic cracking and pyrolyzing is selected from the group consisting of nickel, cobalt, chromium, iron, mixtures thereof, and alloys thereof.

[c22] 22.The gas discharge device according to claim 21 wherein said catalyst is cobalt chromium alloy.

[c23] 23.The gas discharge device according to claim 12 further comprising a background gas contained therein, said background gas being selected from the group consisting of helium, neon, argon, krypton, xenon, and mixtures thereof.

[c24] 24.The gas discharge device according to claim 23 wherein said background gas has a pressure of less than about 0.3 kPa.

[c25] 25.The gas discharge device according to claim 24 further comprising a mercury vapor contained therein.

[c26] 26.A method for making an electron emitter of a gas discharge device comprising the steps of:
providing an amount of carbon nanotubes and an amount of oxygen-containing compounds of alkali-earth metals in proportions such that an electron emission from said carbon nanotubes is a substantial portion of a total quantity of electrons emitted from said electron emitter;
mixing said carbon nanotubes and said oxygen-containing compounds of alkali-earth metals to form a mixture;

providing an electrically conducting structure for said electron emitter;
depositing said mixture on said electrically conducting structure; and
converting said oxygen-containing compounds of alkali-earth metals to alkali-earth metal oxides to form said electron emitter.

[c27] 27.The method according to claim 26 wherein said portion is at least 10 percent.

[c28] 28.The method according to claim 27 wherein said portion is preferably at least 20 percent, more preferably at least 50 percent, and most preferably at least 80 percent.

[c29] 29.The method according to claim 26 wherein said oxygen-containing compounds of alkali-earth metals are selected from the group consisting of carbonates, nitrates, oxalates, citrates, and acetates of alkali-earth metals.

[c30] 30.The method according to claim 26 wherein said structure for said electron emitter is selected from a group consisting of a sleeve, a stick, a coil, a coiled coil, a triple coil, and combinations thereof.

[c31] 31.The method according to claim 26 wherein said depositing is done by a method selected from the group consisting of painting, dipping, spraying, and electrophoresis.

[c32] 32.A method for making an electron emitter of a gas discharge device comprising the steps of:
providing an amount of oxygen-containing compounds of alkali-earth metals and an amount of catalyst particles;
dispersing said catalyst particles in said oxygen-containing compounds of alkali-earth metals to form a mixture;
providing an electrically conducting structure for said electron emitter;
depositing said mixture on said electrically conducting structure;
converting said oxygen-containing compounds of alkali-earth metals to alkali-earth metal oxides; and
forming carbon nanotubes on said catalyst particles to form said electron

emitter.

[c33] 33.The method according to claim 32 wherein said growing comprises cracking and pyrolyzing a hydrocarbon on said catalyst particles at a temperature in a range from about 400 ^{0}C to about 1200 ^{0}C.

[c34] 34.The method according to claim 33 wherein said temperature is preferably in a range from about 400 ^{0}C to about 700 ^{0}C.

[c35] 35.The method according to claim 33 wherein said hydrocarbon is selected from the group consisting of alkynes and alkenes having 2 to 5 carbon atoms inclusive, alkanes having 1 to 5 carbon atoms inclusive, and mixtures thereof.

[c36] 36.The method according to claim 33 wherein said hydrocarbon is sleeted from the group consisting of substituted and unsubstituted aromatic hydrocarbons having 1 to 3 rings inclusive.

[c37] 37.The method according to claim 32 further adding an amount of at least one temporary binder in said mixture while dispersing said catalyst particles.

[c38] 38.The method according to claim 33 wherein said catalyst is selected from the group consisting of nickel, cobalt, chromium, iron, mixtures thereof, and alloys thereof.